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The Nature and Structure of Impediments to EDI Adoption and Integration: A Survey of Small- and Medium-Sized Enterprises

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Electronic data interchange (EDI) is a key enabling component of business-to-business electronic commerce. As firms adopt and integrate advanced information technologies such as EDI, it is important to understand the nature of challenges faced by them. This becomes especially important given the fact that nearly 99.7% of all businesses in the US can be classified as small- to medium-sized enterprises (SMEs). As costs and risks associated with implementing new information technologies decrease, these firms will surely need to focus their attention on managing impediments associated with new technology implementation and learn from the failures or successes of their peers. Consequently, this article reports the findings of a study conducted to understand the characteristics, seriousness, and structure of impediments faced by SMEs. A survey of 353 EDI-capable firms was used to assess the impediments faced by SMEs adopting and integrating EDI. Analysis of data revealed that SMEs face many serious challenges when implementing EDI and cite high startup costs, difficulty of learning a new technology and methodology, and high cost of integration and expansion of EDI use as among the three most significant impediments. Further analysis also produced an eight-factor latent structure that best describes the nature of EDI impediments. These results have implications for both SMEs and researchers.

Electronic data interchange; E-commerce; Small- to medium-sized enterprises (SMEs)

INTRODUCTION

Interorganizational systems such as electronic data interchange (EDI) have the potential of changing the way organizations do business. EDI has become a critical business tool for many large companies (Compaq, 1997; JC Penney, 1997). It is also a critical element of all future business-to-business electronic commerce. In 1995, "of the 5 million to 6 million companies in the U.S. with revenue greater than $1 million, only about 80,000—or less than 1%—were using EDI" (Mohan, 1995). Corporate America's EDI-related expenditures are expected to grow to $6.4 billion by the turn of the century.[1] Furthermore, it is predicted that almost 90% of all businesses will use some form of electronic data transfer in their operations by the end of the century. However, small companies that are at the receiving end of the EDI mandate have failed to obtain the benefits promised by this technology. They are faced with the adoption of a technology that results in enormous challenges for the organization and in some instances has become a drain on the firm's resources.

Small- to medium-sized enterprises (SMEs) employing less than 500 employees constitute 99.7% of all businesses in the US and consequently dominate the typical supply chain of most large companies (EDI World Institute, 1995; National Federation of Independent Business, 1997; Small Business Administration, 1995). Thus, any new information technology (IT) initiative (or imperative) from federal or state level procurement agencies and larger corporate organizations has critical ramifications for small- to medium-sized firms. Although many research studies have investigated the business impact of EDI on large corporate organizations in various industrial sectors (e.g., Arunachalam, 1995; Banerjee & Golhar, 1993; Bergeron & Raymond, 1992; Hansen & Hill, 1989; Hendon, Nath, & Basu, 1995; Massetti, 1991; Pfeiffer, 1992; Vlosky, Smith, & Wilson, 1994), very few have specifically focused on analyzing the impact of EDI on SMEs (e.g., EDI World Institute, 1995; Iacovou et al., 1995; Raymond & Bergeron, 1996).

Therefore, the goal of this article is to describe the findings of a research project undertaken to address the specific issues relating to identifying and evaluating the nature and seriousness of impediments associated with EDI adoption and integration in SMEs.

RESEARCH RATIONALE AND QUESTIONS

The impact of EDI on small businesses can be answered with one word—devastating. After being on EDI for over two years, spending hundreds of hours quoting the

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[1]This estimate includes four revenue components: transaction (VAN, direct, Internet), software (purchase, upgrade, integrate), consulting (internal, external), and hardware (fixed cost) (EDI Group, 1997).

directory and the remaining were located by approaching EDI hub companies and government organizations in the area. Anonymity was promised in return for completed surveys. Various measures to reduce nonresponse rates were also undertaken. In order to boost response rates, nearly 418 follow-up phone calls were made. Approximately 338 companies were called once, 79 called twice, and one was called three times. The first follow-up was done after 2 weeks of the initial survey mailings. After the first follow-up a total of 59 completed survey responses were received giving a response rate of 16.7%. Based on the first follow-up phone call, businesses that had expressly indicated an interest in participating were identified and called the second time around. These efforts culminated in an effective response rate of 24.3%, that is, 86 useful responses.

RESULTS AND DISCUSSION

Description of Survey Sample

Industrial Sector and Range of Products. All 86 responding firms provided information about their industrial sector. The two largest categories are manufacturing (57%) and wholesale trade (27%) making up nearly 84% of the sample. The remaining include a large number of retail (7%) and services sector (2%) firms. The responding firms offer a range of products and services. In the manufacturing sector, participating firms make a diverse range of products including everything from industrial parts and supplies to candy and cheesecakes. In the wholesale trade sector, firms deal in products ranging from industrial parts and supplies to food and pharmaceuticals. The remaining firms are involved in retail trade such as office furniture and power tools, services such as health and lab analysis, and other business activities such as hauling freight, warehousing, logistics management, and computer systems value-added reselling (VAR).

Respondent's Position. Survey respondents representing the sampled organizations were also asked to identify their position and functional area. An equal number (43) of individuals belonged to the nontechnical managerial or administrative ranks as those from the information systems branch. This result is interesting in that it is a positive change from the reported respondent profiles in previous studies.[3] It is also in line with the notion that EDI is an organizational problem rather than a purely technical one. The result also demonstrates that this concept is gradually shaping how small firms plan to use new information technologies in the long term.

Organizational Size. Nearly 49% of the responding firms have less than 100 full-time employees with 36% having less than 50 employees. Organizations with more than 100 employees but less than 500 made up 36% of the sample. A large number (nearly 70%) of responding firms had gross sales over $1 million in 1997 with more than half (47%) generating over $10 million in sales. The remaining firms were evenly split between $10.000 and $1 million in gross sales. Nearly a dozen firms (14%) did not reveal their sales numbers by marking "don't know."

EDI Experience.[4] *New EDI users*, organizations with EDI experience of less than or equal to 12 months, made up nearly 10% of the number of respondents. *Experienced EDI users*, organizations with more than 1 year and less than 5 years of experience made up 56% of the sample. *Long-term EDI users*, organizations with more than 5 years of experience, made up nearly 34% of the sample.

Characteristics of EDI Operation in Surveyed Organizations

Means of Communication. There are three generic approaches to implementing EDI links (Jillovec, 1993). The first approach involves the use of a direct EDI link between vendor and customer using a modem and telephone line. Trading partners establish communications using a dial-up link to the hub's network. While a majority of these hubs do not charge for their network service, trading partners do have to pay all phone charges.

The second approach involves using indirect EDI links through value-added networks (VAN) or "third-party electronic clearing houses" between trading partners. These independent EDI networking vendors provide all the necessary software and communications services and essentially perform the function of an electronic post office for numerous business partners. Trading partners place their business documents in "electronic envelopes" identifying the sender and receiver. The document is mailed to the VAN after setting up a dial-up link via phone lines. The VAN will either forward the document to the hub organization's computer automatically or place it in the receiver's mailbox for pickup at a later time. Major costs associated with this EDI transmission option will include expenses relating to VAN setup, telephone lines, and monthly transaction fees.

With the development of better Internet browsers and compatible EDI software that incorporates adequate security measures including encryption, the robust and cheaper Internet is fast becoming a medium of choice

[3]For example, both Pfeiffer (1992) and Bergeron and Raymond (1992) found that EDI was largely the responsibility of an organization's technical (IS) manager.

[4]The classification of EDI experience used here is based on Pfeiffer (1992).

ousness of EDI impediment" variable presented in Table 5 is also useful for clarifying the earlier results. Based on average "seriousness" scores for all impediment items that were not marked as "not an impediment," the *three most serious* impediments faced by sampled SMEs are "ability to seamlessly integrate existing applications with existing internal applications" (1.96), "learning new technology and methodology" (1.92), and "high startup costs" (1.89). These three impediments are closely followed by a tie between "availability of managerial time to expand EDI use" and "translating customer/supplier data for direct use in internal applications" with an average seriousness score of 1.88.

All the EDI impediments listed in Table 5 received mean "seriousness" scores of greater than 0, indicating that surveyed organizations did encounter these impediments, but with varying degrees of difficulty. It is also interesting to note that the seriousness of all the EDI impediments varies from a low of 1.35 (not serious at all = 1.00) to a high of only 1.96 (somewhat serious challenge = 2.00 and extremely serious challenge = 3.00). This result suggests that a majority of the impediments to EDI adoption and integration faced by the sampled firms are serious, but are not insurmountable challenges.

Hence, it can be concluded that the surveyed firms find the costs for EDI setup and ongoing integration to be high but not prohibitive. Further, SMEs face significant challenges in changing the way they do business while finding managerial time to learn and implement a new technology and trading procedures.

The Structure of EDI Impediments

The EDI impediment items were also further analyzed on the seriousness scale using the "principal components analysis (varimax rotation with Kaiser normalization)" statistical technique.[7] This exploratory factor analysis was used to identify any underlying factors that

[7]SPSS/PC version 8.0 was utilized for statistical analysis.

Table 5. Seriousness of EDI Impediments (Descriptive Statistics)

EDI Impediments	*N*	Mean	SD
Ability to seamlessly integrate EDI with existing internal applications	70	1.96	0.82
Learning new technology and methodology	72	1.92	0.69
High startup costs	80	1.89	0.66
Availability of managerial time to expand EDI use	69	1.88	0.78
Translating customer/supplier data for direct use in internal applications	68	1.88	0.70
High cost of integration and expansion of EDI use	74	1.84	0.68
Changing business processes	69	1.80	0.63
Absence of uniform EDI standards	68	1.79	0.74
End users' and customers' continued reliance on paper-based transaction	74	1.77	0.69
Dealing with multiple EDI formats	60	1.77	0.72
Exposure to ever-changing customer/supplier requirements about EDI system	67	1.73	0.66
Implementing multiple trading partners	65	1.72	0.72
Availability of technological resources	72	1.72	0.72
Understanding potential benefits of EDI	71	1.70	0.78
Availability of financial resources	74	1.68	0.70
Complexity of the technology	74	1.66	0.67
Integrating multiple EDI systems and/or VAN connections	57	1.63	0.75
Overcoming resistance to change	67	1.63	0.65
Considering EDI as a natural extension of preexisting internal operations	71	1.62	0.72
Maintaining one system for EDI-capable & another for non-EDI-capable partners	59	1.61	0.72
Managing data and transmission security and auditability	59	1.56	0.62
Increased responsibility for employees	67	1.55	0.61
Obtaining general information about EDI	74	1.54	0.69
Impersonal nature of EDI	56	1.54	0.71
Low volume or frequency of orders	60	1.53	0.79
Determining appropriate internal applications to apply EDI	68	1.49	0.63
Small size of business	60	1.45	0.65
Gaining management/stakeholder commitment	61	1.44	0.59
Addressing legal issues (e.g., electronic orders, signatures, legal agreements)	55	1.42	0.57
Selecting the hardware to run EDI software	61	1.38	0.58
Selecting means for communications with trading partners	65	1.35	0.54

This descriptive analysis of the "seriousness of EDI impediments" variable is based on the following ratings: "not serious at all" (1), "somewhat serious challenge" (2), and "extremely serious challenge" (3).

Table 6. Factor Loadings for EDI Impediment Construct[a]

	Factor[b]							
EDI Impediments	1	2	3	4	5	6	7	8
Increased responsibility for employees	**0.80**							
Changing business processes (new way of thinking about & doing business)	**0.66**							0.29
Overcoming resistance to change	**0.65**					0.30		
Small size of business	**0.63**							
Gaining management/stakeholder commitment	**0.57**			0.36	0.30			
Integrating multiple EDI systems and/or VAN connections		**0.84**						
Dealing with multiple EDI formats		**0.80**			0.27			
Absence of uniform EDI standards		**0.77**			0.29			
Implementing multiple trading partners		**0.63**					0.48	
Selecting means for communications with trading partners (e.g., choice of third-party VANs)		**0.43**		0.32				0.33
Understanding potential benefits of EDI	0.28		**0.81**					
Considering EDI as a natural extension of preexisting internal operations	0.33		**0.80**					
Availability of managerial time to expand EDI use			**0.52**	0.52		0.32		
End users' and customers' continued reliance on paper-based transactions		0.33	**0.46**		0.39		0.29	
Determining appropriate internal applications to apply EDI				**0.72**				
Translating customer/supplier data for direct use in internal applications				**0.68**	0.39			
Selecting the hardware to run EDI software	0.42			**0.59**				
Ability to seamlessly integrate EDI with existing internal applications	0.39		0.39	**0.50**				
Managing data and transmission security and auditability					**0.82**			
Exposure to ever-changing customer supplier requirements about EDI system (e.g., lack of audit trails)		0.43			**0.62**			
Addressing legal issues (e.g., electronic orders, signatures, legal agreements)			0.42		**0.60**		−0.28	
Availability of financial resources						**0.89**		
High startup costs						**0.80**		
High cost of integration and expansion of EDI use						**0.66**		−0.25
Availability of technological resources[c]			0.48			**0.45**		
Obtaining general information about EDI			0.30				**0.70**	0.29
Learning new technology and methodology (e.g., trading partner's new procedures)	0.34						**0.56**	
Complexity of the technology				0.47			**0.54**	0.34
Low volume or frequency of orders								**0.81**
Maintaining one system for EDI-capable & another for non-EDI-capable partners					0.31			**0.60**
Impersonal nature of EDI[d] (e.g., lose touch with customers/suppliers)					0.58		0.28	**0.42**
Eigenvalues	3.4	3.3	2.9	2.8	2.8	2.0	2.1	1.9
% of variance	10.9	21.7	31.1	40.3	49.3	58.0	64.7	70.9
Cronbach's alpha	0.78	0.79	0.81	0.78	0.75	0.76	0.78	0.64
Mean interitem correlation	1.2	1.2	1.5	1.3	1.2	1.6	1.5	1.1

[a]Rotation converged in 13 iterations. [b]Cross-loadings between factors below 0.25 are not shown. [c]Although this item has a marginally higher loading on factor 3, it is included under factor 6 because it is conceptually closely related with the other items in the latter. [d]Although this item has a marginally higher loading on factor 5, it is included under factor 8 because it is conceptually closely related with the other items in the latter.